

CLAIMS

1 1. A sonic actuator comprising:

2 a multi-layer membrane including

3 a non-metallic elastomeric dielectric polymer layer having a first
4 surface and a second surface;

5 a first compliant electrode layer contacting said first surface; and

6 a second compliant electrode layer contacting said second surface;

7 and

8 a support structure in contact with said sonic actuator film.

1 2. A sonic actuator as recited in claim 1 wherein said non-metallic dielectric polymer
2 is selected from the group consisting essentially of silicone, fluorosilicone, fluoroelastomer,
3 natural rubber, polybutadiene, nitrile rubber, isoprene, and ethylene propylene diene.

1 3. A sonic actuator as recited in claim 1 wherein said compliant electrode layer is
2 made from the group consisting essentially of graphite, carbon, conductive polymers, and thin
3 metal films.

1 4. A sonic actuator as recited in claim 1 wherein said support structure is a grid
2 having a plurality of apertures.

1 5. A sonic actuator as recited in claim 4 wherein said multi-layer membrane is
2 biased such that portions of said film bulge at at least some of said apertures.

1 6. A sonic actuator as recited in claim 5 wherein said multi-layer membrane is
2 biased such that portions of said film bulge in a first direction at at least some of said apertures.

1 7. A sonic actuator as recited in claim 5 wherein said multi-layer membrane is
2 biased such that portions of said film bulge in a first direction at some of said apertures and such
3 that portions of said film bulge in a second direction at others of said apertures.

1 8. A sonic actuator as recited in claim 6 wherein said film is biased by a gaseous
2 pressure that is greater than atmospheric pressure.

1 9. A sonic actuator as recited in claim 6 wherein said film is biased by a gaseous
2 pressure that is less than atmospheric pressure.

1 10. A sonic actuator as recited in claim 6 wherein said film is biased by a soft foam
2 material.

1 11. A sonic actuator as recited in claim 10 wherein said soft foam material is a closed-
2 cell foam with an average cell diameter substantially less than a diameter of said apertures.

1 12. A sonic actuator as recited in claim 7 wherein said film is biased by a gaseous
2 pressure that is greater than atmospheric pressure where said film is bulging in a first direction,
3 and is biased by a gaseous pressure that is less than atmospheric pressure where said film is
4 bulging in a second direction.

1 13. A sonic actuator as recited in claim 5 wherein said support structure is
2 substantially planar proximate to said apertures and wherein said bulging portion of said film
3 exhibit an out-of-plane deflection.

1 14. A sonic actuator as recited in claim 1 wherein said multi-layer membrane
2 comprises a sandwich structure having a plurality of layers of non-metallic elastomeric dielectric
3 polymers alternating with a plurality of layers of compliant electrodes.

1 15. A sonic actuator as recited in claim 1 further comprising a square root driver
2 coupled to said first compliant electrode and to said second compliant electrode.

1 16. A sonic actuator as recited in claim 15 wherein said square root driver includes a
2 summer adding a low power input signal to an offset voltage and a square root generator coupled
3 to an output of said summer.

1 17. A sonic actuator as recited in claim 16 further comprising a filter coupled to an
2 output of said square root generator.

1 18. A sonic actuator as recited in claim 17 further comprising an amplifier coupled to
2 an output of said filter to provide a signal to drive said multi-layer membrane.